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ECOLOGICAL CHANGES IN THE CHENA RIVER

Paul J. Frey

Federal Water Pollution Control Administration
College, Alaska

April 1969

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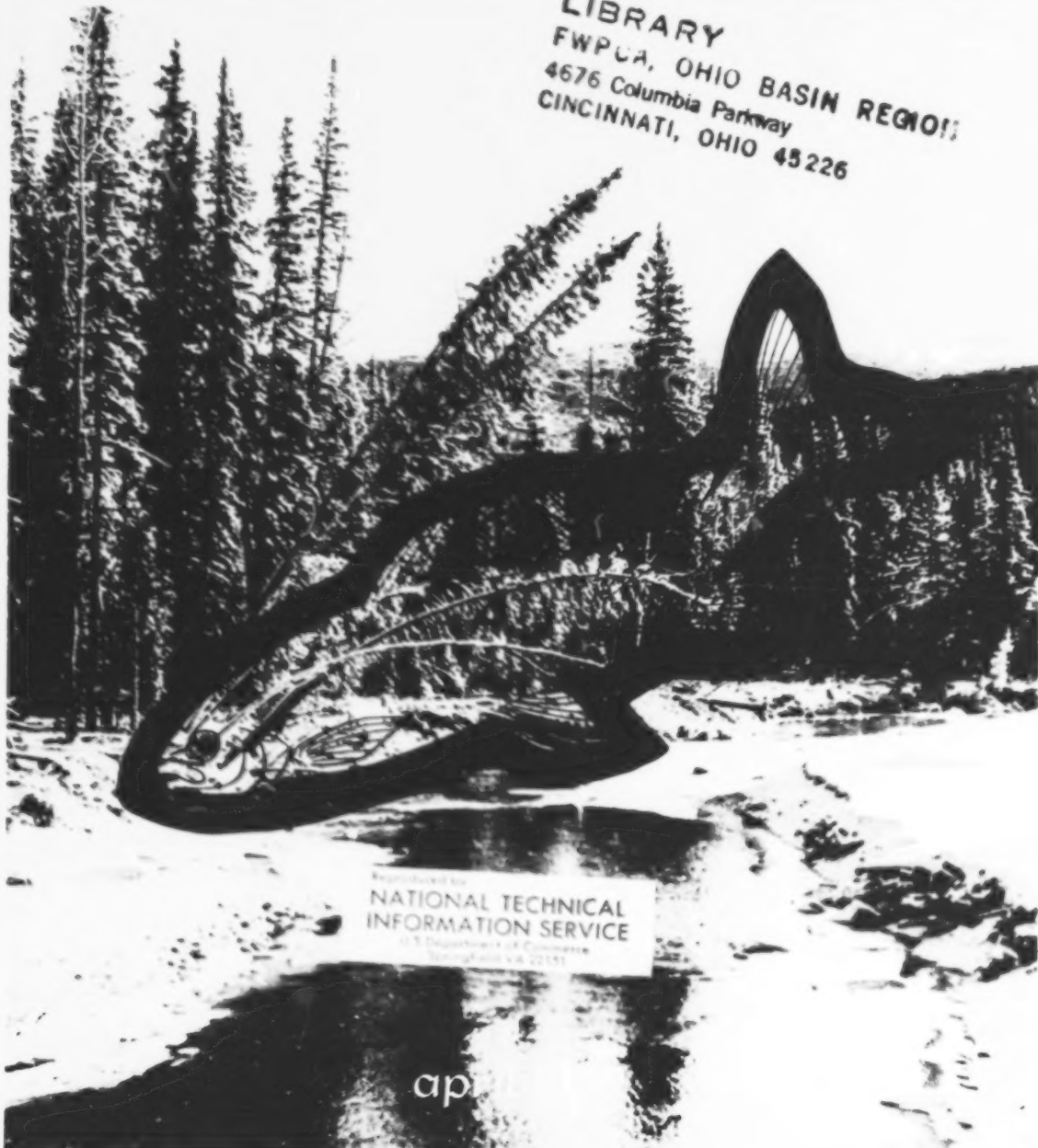
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ECOLOGICAL CHANGES IN THE CHENA RIVER

Prepared By

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Details of illustrations in this
document may be better studied
on microfiche.

United States Department of the Interior
Federal Water Pollution Control Administration, Northwest Region
Alaska Water Laboratory
College, Alaska 99701

April 1969

I

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I. INTRODUCTION

The 1966-67 biological data presented in this report were acquired during an extensive survey of the Chena River to determine the base level conditions prior to the construction of flood control facilities. While gathering historical data during the initial phase of that study, information on various water quality parameters in the river was discovered which suggested that conditions in the river had changed considerably during the past 10 to 15 years. As the study progressed, additional information created an interest that led to side excursions in search of still further information on past conditions of the river and economical practices which may have caused those conditions. Those excursions form the basis for this report.

In preparing a report such as this, it is necessary to call upon all possible assistance. As a result, the author acknowledges assistance by personnel from the U. S. Soil Conservation Service, U. S. Geological Survey, Arctic Health Research Laboratory, U. S. Fish and Wildlife Service, Alaska Department of Fish and Game, University of Alaska, U. S. Smelting, Refining and Mining, Alaska Division of Mines and Minerals, and others of the Alaska Water Laboratory staff.

II. SUMMARY

During the past 10 to 15 years human population densities have changed and economic practices have evolved which have brought about ecological changes in the Chena River. Some of the more obvious changes and their effects on the river follow:

1. The population along the river has increased about 57%, resulting in an increased amount of waste discharged to the river; however, the 1966 waste contained a lower BOD (biochemical oxygen demand) load than did the 1955 waste.
2. Gold mining activities have decreased.
3. Agriculture rose to a maximum in the late 1950's, then subsided with no significant effects.
4. Gravel washing and road construction have caused intermittent turbidity in the river.
5. Construction of the Moose Creek Dike restricts the Tanana River to its own flood plain, thereby removing a large contribution of glacial silt to the Chena.

Probably as a result of these changes, the Chena River and its fauna have reacted in the following manner:

1. Chemical characteristics, except for the pH and dissolved oxygen, have shown little change.
2. Hydrogen ion concentration shifted from basic to acid.

3. Dissolved oxygen remained appreciably higher during the 1967-68 sampling period than during the 1951-52 sampling period.

4. Extensive silt banks present during 1953-54 have disappeared and the bottom now consists of cleanly washed sand and gravel.

5. Coliform counts in 1966 show a general increase over the 1953-54 period in the lower river.

6. The bottom fauna in 1967 has shown marked improvement over the 1953-54 fauna, but still shows signs of effects of pollution.

7. Fishing has improved in the lower river.

III. DESCRIPTION OF THE AREA

The Chena River originates in a mountainous area about 90 air miles east of Fairbanks, Alaska, at longitude 144°45'W., and latitude 65°10'N (Figure 1). Its basin consists of four major subbasins: North Fork, East Fork, South Fork, and Little Chena River. At present it is an unregulated stream approximately 150 miles long with a watershed of approximately 1,980 square miles. It is nonglacial with many groundwater sources along its way. Several of the groundwater sources are quite warm, reaching a maximum of 160°F. at Chena Hot Springs on the North Fork. The average discharge at Fairbanks is 1,344 cfs with a range of 100-74,400 cfs. Maximum discharge is usually reached during April and May, resulting from spring rains and breakup. Normal flows occur during the summer, with extreme lows usually occurring during the winter season. Water temperatures range from near 0°C. during the winter to 15-17°C. in July. Ice begins to form on the river in October and spring breakup occurs in April and May. Warm water seeps along the Chena's course limit the extent of complete ice cover to periods of extremely low temperature.

The climate of the area is characterized by long cold winters and short moderate summers. Air temperatures range from -60°F. to +90°F. Annual precipitation is about 11 inches.

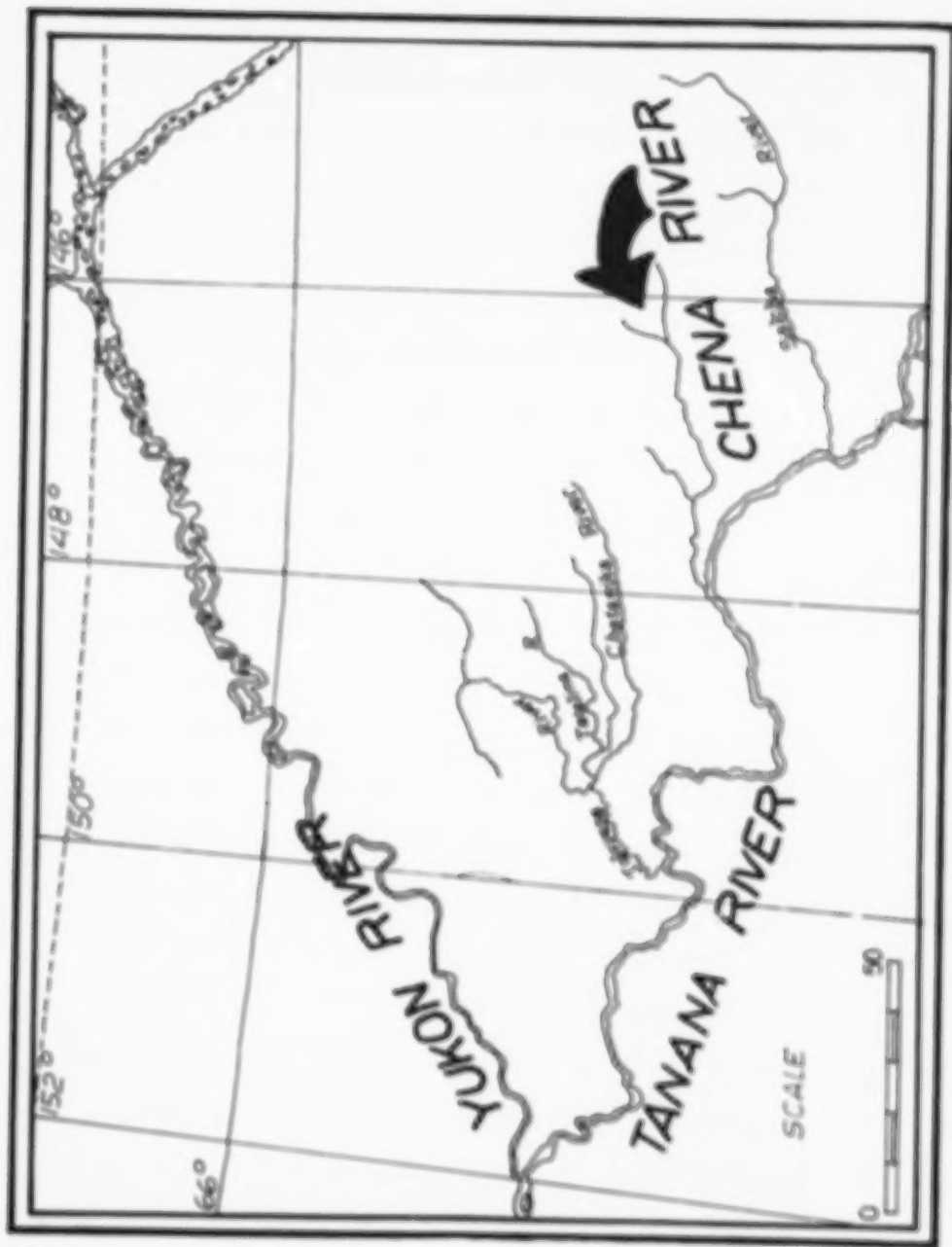


Figure 1. Map of the Chena River Drainage System, Showing its Location and Position in Relation to the Tanana and Yukon Rivers.

After leaving its mountainous headwaters, the Chena River flows in a southwesterly direction to terminate at its junction with the Tanana River several miles southwest of Fairbanks. Vegetation within the watershed consists of forested mountains near the headwaters (Figure 2), changing to muskeg and scrub as it reaches its mouth (Figure 3). Low areas are covered by black spruce, willow and sedge with brush patches, potholes and tussock flats scattered throughout. The better drained land supports stands of white spruce, aspen, poplar and birch.

In the early 1920's there was limited gold mining on the upper reaches of the East Fork; however, by 1940 virtually all mining operations had ceased. During the past years, road construction has caused intermittent turbidity in the river. At present, however, the upper Chena is little influenced by man's activities. From river mile 80 downstream, there is limited homesteading activity. One of the major tributaries, the Little Chena, enters the river at about river mile 28. Various parts of this drainage basin have been mined extensively since the turn of the century. The last important tributary, the Chena Slough (Thirty-Mile Slough), enters the river at approximately river mile 30. This slough drains an area of considerable human habitation. Fort Wainwright, an Army installation, lies along the river at about mile 15. The Fairbanks-College-Graehl-Lemeta complex is immediately below this point and extends nearly to the mouth of the river.

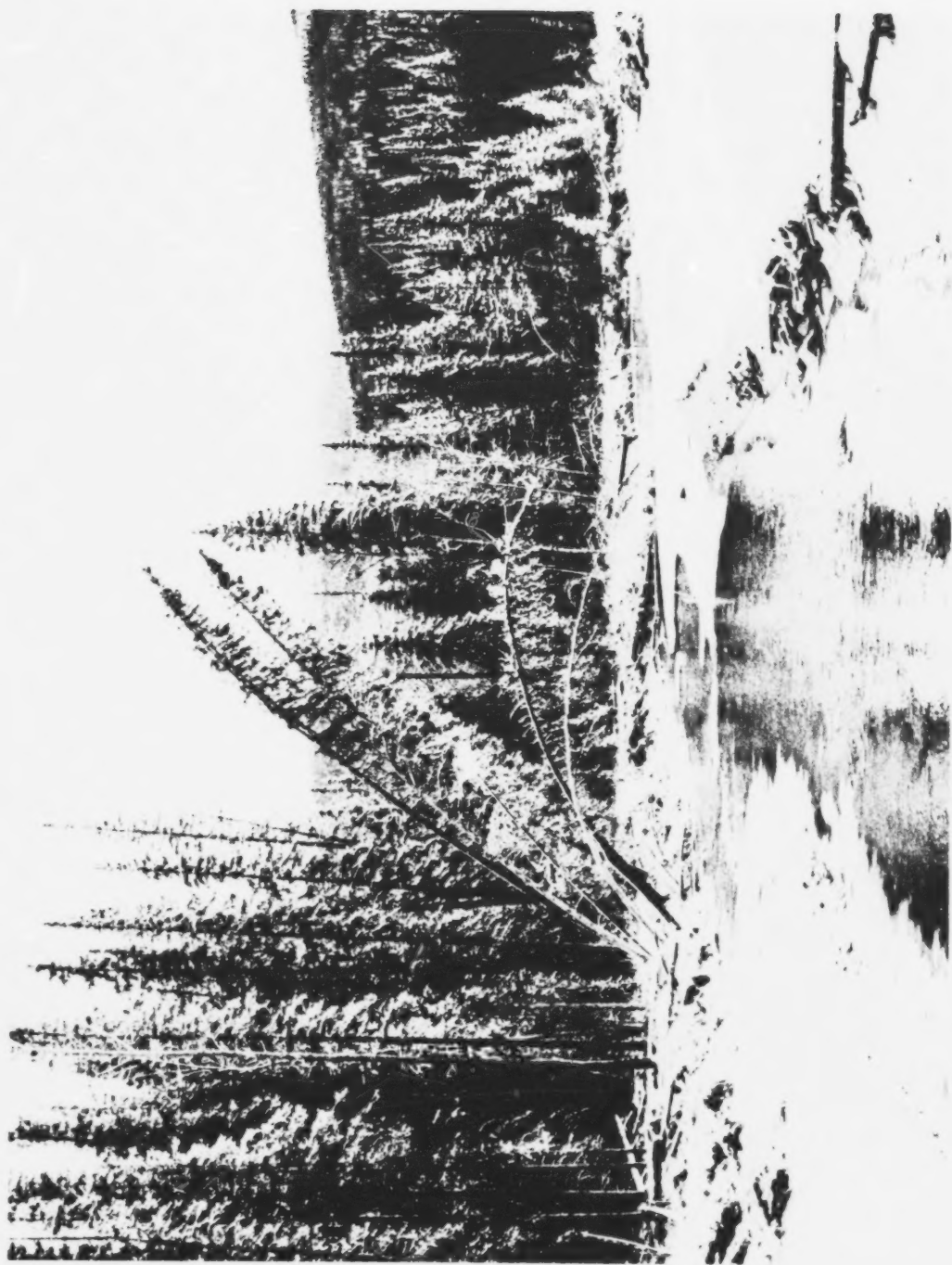


Figure 2. Moderate Stands of Spruce Along the Headwaters of the Chena River.



Figure 3. Typical Terrain of Muskeg and Scrub Near the Mouth of the Chena River.

As a result of past practices and present inhabitation trends, the river can be divided into an upper area of approximately 120 miles, virtually unaffected by man, and a lower area of approximately 30 miles which has been and still is grossly affected by man's activities (Figure 4).

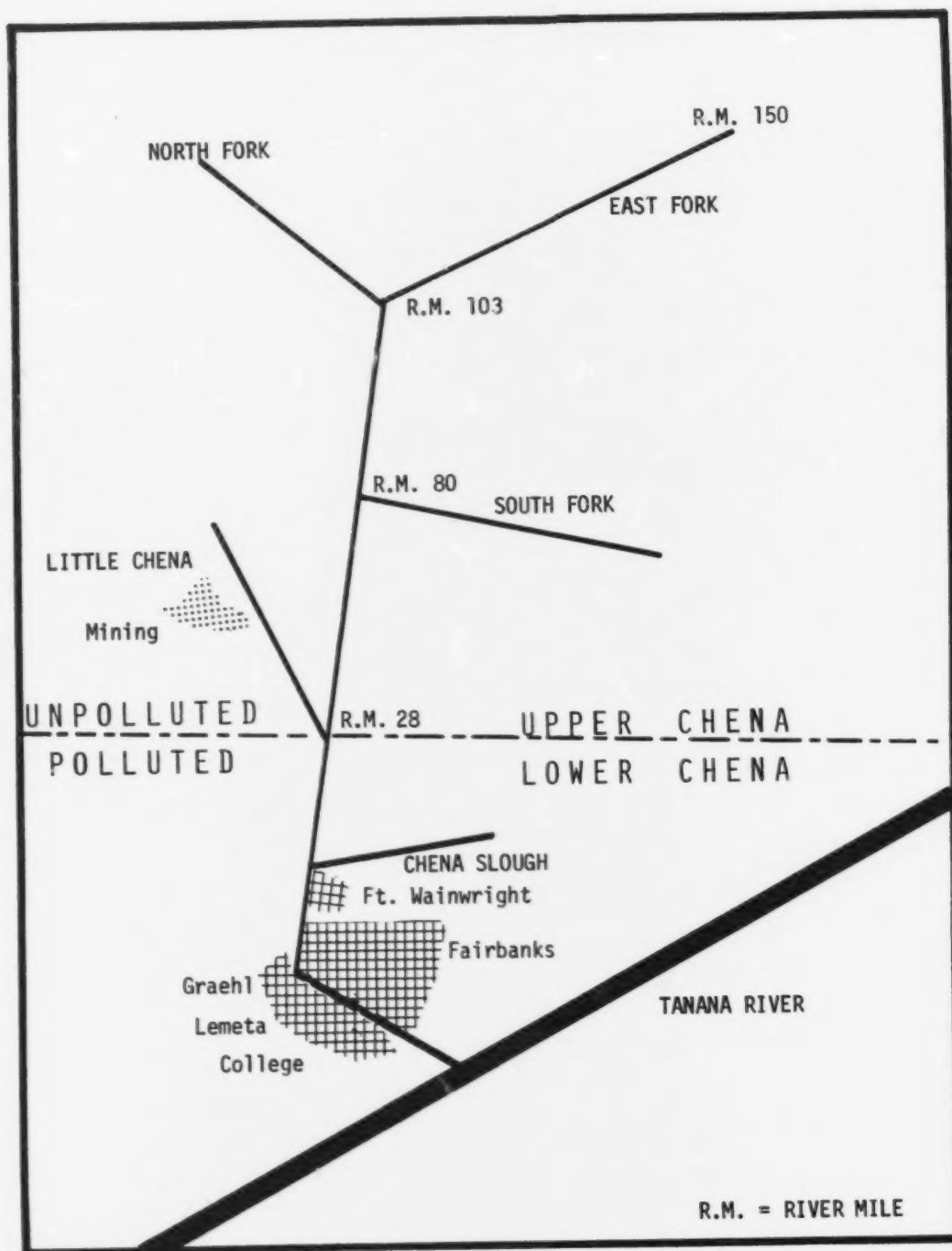


Figure 4. Diagrammatic Drawing of Chena River, Showing the Major Tributaries and the Polluted and Unpolluted Areas.

IV. ECONOMIC PRACTICES AFFECTING THE RIVER

Most of Alaska's vast interior remains in a relatively unchanged state even though it has been trampled by the feet of thousands of gold miners and other fortune hunters since before the turn of the century. The Chena River not only coursed an area of vast gold deposits, but also emptied into the Tanana River, which was a navigable waterway to the Bering Sea and the outside world. In 1901, E. T. Barnette, because he could proceed no farther up the Tanana River with the boat he had, erected on the Chena River bank a log cabin cache of trade goods, the first building in Fairbanks. Before Barnette could build a better boat, Felix Pedro discovered gold in the area and the stampede was on. Since then, Fairbanks has developed into the trading center for the Interior, growing into the second largest city in Alaska.

To understand how the Chena River has reached its present ecological condition, it is necessary to compare historically activities along its watershed and indicate how these have changed. The following are the major influences that have been responsible.

Population Trends

In 1950 the population of Fairbanks proper was 5,771. In the Fairbanks area, the total population, including the military, was then approximately 37,000 (Table 1). Of this total, only the

TABLE 1

POPULATION OF FAIRBANKS AND SURROUNDING AREA DISCHARGING
DOMESTIC WASTE INTO THE CHENA RIVER IN 1950 AND 1966

Date	Fairbanks City Limits	Fairbanks Area Including Fort Wainwright
1950	5,771	37,000
1966	17,800	58,000

TABLE 2

CHENA RIVER AT FAIRBANKS

Approximate Domestic Waste Volume and Concentrations
Discharged to River

Outfall	1955*		1966	
	BOD PPM	Approx.Flow MGD	BOD	Approx.Flow MGD
Ft. Wainwright South	56	1.06	120	0.90
Ft. Wainwright North	71	0.61	120	0.45
Fairbanks Main Outfall	360-480	0.62	200	1.50
Island Homes	103	0.06	200	0.09
Westgate	175	0.01	300	0.04
Weeks Field	262	0.06	--	--
Betty Street	285	0.01	--	--
Charles Street	353	0.01	--	--
Grachl	--	--	300	0.02
Hamilton Acres	--	--	300	0.04
College Utility Corp.	--	--	100	0.10
Noyes Slough	--	--	100	0.02
Total		2.44		3.16

*Taken from Alaska Water Pollution Control Board Report #8,
Chena River Survey

military had sewage treatment. The volume of domestic waste entering the river totaled approximately 2.44 mgd (Table 2). The population of Fairbanks in the 1966 census was 17,800 and the total population contributing domestic waste to the river was approximately 58,000. This is now discharging approximately 3.24 mgd of sewage, ranging from secondary treatment with over 90% BOD removal to a small percentage still untreated.

Mining

Just at the turn of the century, gold was discovered on Fairbanks Creek, a tributary of the Little Chena River. By 1910, 500 people were living and working on it and nearby creeks. Many of these worked their own small operations; others worked for larger companies which had become established. At the height of the mining activity, several large dredges were operating. By 1950, only three major operations were still active. By the early 1960's, the number had been further reduced until, at present, only one operation remains. Nevertheless, all of the major operators have patented claims and would reactivate if the price of gold were to rise.

Agriculture

According to the County Agent with the U. S. Soil Conservation Service, agriculture in the Chena River basin has been limited; prior to 1950 it was negligible. In the middle 1950's

there was a surge in agricultural activity and approximately 7,000 acres of land was cleared and a moderate amount of farming was in progress. During that period, the major effort was in potatoes, with dairying second and grain crops third. Since then the dairy market has been lost, resulting in the elimination of dairies from the valley. At present, approximately 1,700 acres remain in cultivation, with only 3 to 4% of the operators spending 100% of their effort in agriculture.

It is highly unlikely that agriculture, even during its most aggressive period, had any significant effect on the Chena River. Even though the soil in the area is subject to erosion, most of the farms were located some distance from the river and any erosion that did take place was not felt by the river because of the filtering action of the muskeg.

Gravel Washing

There have been a considerable number of gravel washing operations in the lower river during the past years. The operation consists of removing sand and gravel from the river bed with a dragline located on the river bank. The sand and gravel are placed on the river bank and prepared for commercial use. The operation causes considerable turbidity in the river during both the removal and the preparation of the sand and gravel. At present only two such operations are active in the Fairbanks area.

Road Construction

Road construction in the upper Chena River valley produced considerable turbidity in those reaches of the Chena River during 1964-65. However, this has now been reduced to a minimum.

Moose Creek Dike

The Moose Creek Dike was constructed in 1939 to keep the Tanana River from pouring into the Chena during periods of high water. It was, however, constructed of porous material which allowed considerable water to escape into the Chena River through the Chena Slough. A considerable volume of water still entered the Chena system from the Tanana in 1953-54. Some time between then and 1966, the dike became sealed and now effectively controls the Tanana in that area. Waters of the Tanana are heavily laden with glacial silt, so with its removal, the Chena Slough is now a clear-running, spring-fed tributary of the Chena River.

V. OBSERVATIONS

The observations and conclusions in this paper are derived from comparison of data and observations collected from widely separated periods of time by people with widely varying scientific backgrounds. In addition, sampling and storing methods have been improved and analyses have become more sophisticated. It is, therefore, necessary to keep in mind that direct comparisons are probably unrealistic and that general trends are more important than exact entities.

Chemical

Chemical analyses have probably seen the greatest change during the period over which the data in this paper are concerned. To eliminate as much error as possible from differences in methodology, two sets of data collected by the Water Resources Division of the Geological Survey (Tables 3 and 4) have been selected for comparison. Unfortunately, discharge levels and sampling dates do not correspond well; however, it is important to note that only slight differences occur in the over-all chemical picture. There are two important differences, however, the variations in pH and dissolved oxygen from the two periods of time. During the 1953-54 period the pH ranged from neutral to basic, while the 1967-68 pH ranged from neutral to acidic. Since pH is such an ephemeral thing, it is difficult to say whether this is a reaction to a

TABLE 3
CHENA RIVER AT FAIRBANKS
Chemical Analyses, in Parts Per Million, October 1953-September 1955*

Date of Collection	Mean Discharge (cfs)	Silica (SiO ₂)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO ₃)	Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrate (NO ₃)	Dissolved solids (Residue on evaporation at 180°C.)	Hardness as CaCO ₃ Calcium magnesium	Non-carbonate	Specific conductance (Micromhos at 25°C.)	pH	Color
<u>1953</u>																		
Oct. 1-7	1,614	11	0.01	25	5.2	3.0	1.4	84	20	0.8	--	1.2	115	84	15	177	7.3	5
<u>1954</u>																		
Jan. 27	170 ^{a/}	20	.00	32	7.9	4.6	2.5	132	16	2.2	--	1.8	158	112	4	233	8.2	5
May 14	2,050	8.8	--	--	--	1.9	.6	62	17	.5	--	1.5	--	--	--	136	7.3	--
Oct. 10	1,440	9.4	.19	24	5.4	2.4	.8	81	19	1.0	--	1.4	104	82	16	170	7.1	10

*Data taken from Water Quality Records, 1954, U. S. Geological Survey

^{a/}Discharge at time of sampling

TABLE 4
CHENA RIVER AT FAIRBANKS
Chemical Analyses, in Parts Per Million, September 1967-May 1968*

Date of Collection	Mean Discharge (cfs)	Silica (SiO ₂)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO ₃)	Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrate (NO ₃)	Dissolved solids (Residue on evaporation at 180°C.)	Hardness as CaCO ₃ Calcium magnesium	Non-carbonate	Specific conductance (Micromhos at 25°C.)	pH	Color
1967																		
Sept. 8	3,250	10	0.78	31	0.8	1.8	1.1	83	14	1.1	.0	0.9	103	80	12	155	7.2	10
1968																		
April 3	350	11	1.35	23	6.9	2.7	1.6	86	17	.4	.2	.0	106	86	16	188	6.8	15
April 5	390	15	.68	31	7.3	3.4	1.8	120	16	.4	.1	1.1	135	108	10	222	6.9	0
May 3	1,700	8.5	.67	23	5.3	2.0	1.4	76	17	.8	.1	.6	96	80	18	155	7.1	50
May 7	5,130	4.6	.71	13	3.0	.9	1.0	38	12	.6	.2	.7	56	45	14	88	6.8	130

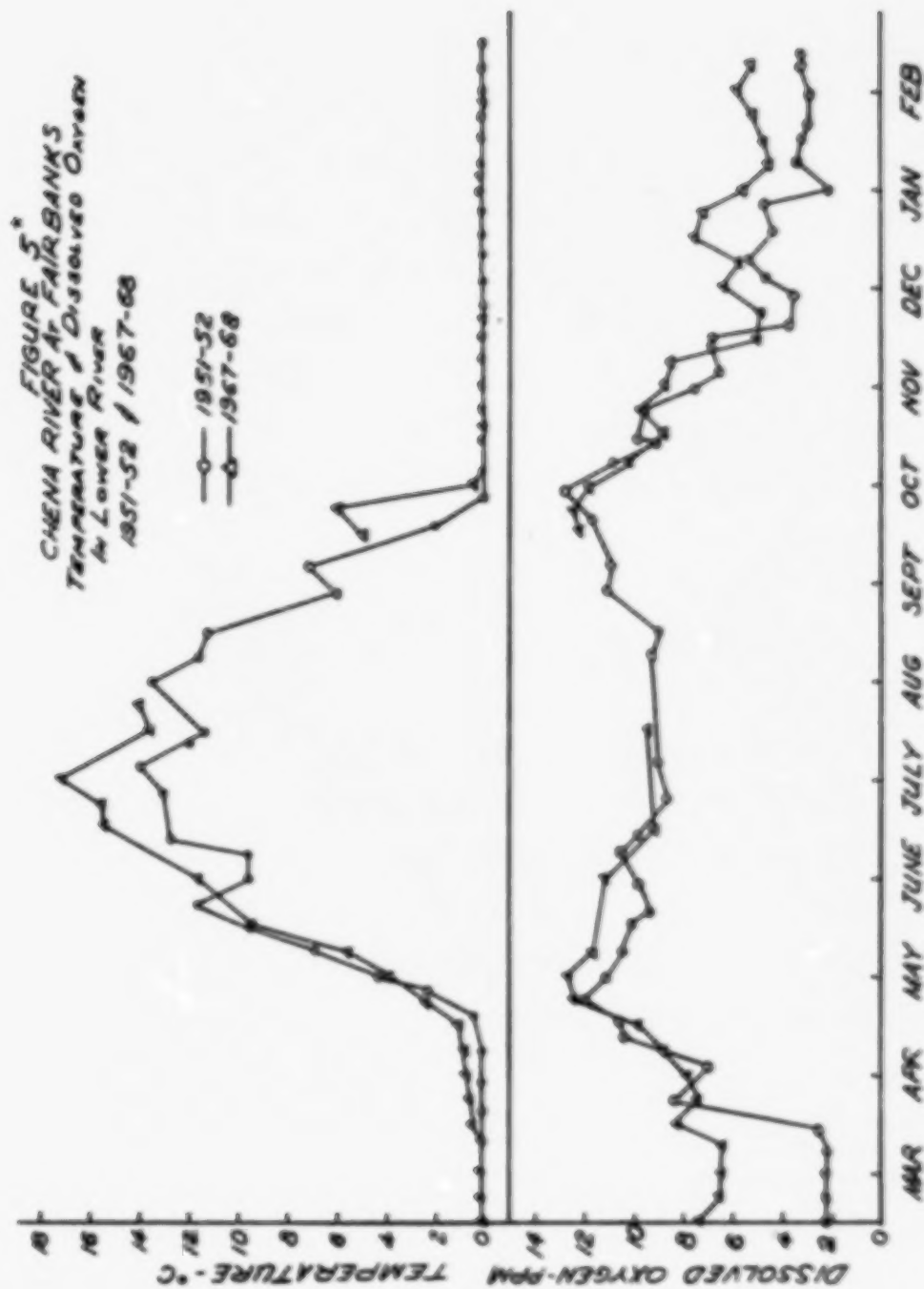
*Unpublished data, U. S. Geological Survey

change in the environment. It is noteworthy that the low pH during the 1967-68 period came during the time when the river was open, but carrying a very light sediment load, and the higher pH of the 1953-54 period also came during the open water season, but when the river was carrying a very heavy silt load.

Figure 5 shows the temperature and dissolved oxygen regimes of the river during the 1953-54 and 1967-68 periods. The temperature profiles for the low periods are similar. Although temperatures were slightly higher in 1967-68, the rise and fall from approximately 0.1°C . to 0.1°C for both periods of time are nearly identical. Dissolved oxygen profiles, on the other hand, are not identical. These data are of extreme importance since the lows during the 1967-68 period remained considerably higher than they did during the 1953-54 period. Since low dissolved oxygen is directly associated with ice cover, the close correlation between the temperatures for the two periods is important because it points up that the differing dissolved oxygen levels for the two periods were not due to a difference in ice cover, but must be a reaction to other factors in the environment.

Physical

According to personnel involved in the 1953-54 sampling period, extensive silt banks were in evidence from the mouth of the Little Chena downstream to the mouth of the Chena River.



*Taken from Alaska Water Pollution Control Board Report #8, Chena River Survey

During the 1966-67 sampling period, the river bottom in that same reach consisted of cleanly washed sand and gravel. Data in Tables 5 and 6 explain why the change has taken place. Table 5 (1954) shows that, during the ice-free months, the concentration of suspended sediment ranged from a low of 94 ppm to a high of 788 ppm. In comparison, the 1965-66 data (Table 6) showed a low of 12 ppm and a high of 46 ppm. The data further point out that freshets resuspended sediments that had collected on the river bottom during the 1954 period, but had little effect in the 1965-66 period.

Biological

Bacteriological Data

Table 7 contains coliform data collected during 1953 by Public Health Service personnel, given in MPN/100 ml and derived by the multiple dilution tube method. Table 8 contains coliform data collected in 1966, derived by the membrane filter technique and given in counts/100 ml. Work at the Alaska Water Laboratory shows a close correlation between membrane filter counts and MPN/counts from the multiple dilution tube method for the waters from the Chena River. Since no data are available for the low water period (winter) in 1953, we can compare only the summer counts. These, too, are rather difficult to compare since discharges differ considerably; however, it is quite obvious that counts in 1966 are

TABLE 5

CHENA RIVER AT FAIRBANKS

Periodic Determinations of Suspended-Sediment Discharge, 1954*

Date	Discharge (cfs)	Suspended Sediment	
		Mean concentration (ppm)	Discharge (tons per day)
<u>1954</u>			
Jan. 27	170 ^{a/}	9	4
May 14	1,970 ^{a/}	210	1,120
May 24	1,420	135	518
June 7	1,840 ^{a/}	331	1,640
June 23	1,160	144	451
July 1	825	166	370
July 8	870	94	221
July 17	922	199	495
July 29	2,950	788	6,280
Aug. 6	2,080	278	1,560
Aug. 12	1,430	190	734
Aug. 20	1,160 ^{a/}	114	357
Oct. 10	1,440	24	93

* Data taken from Water Quality Records, 1954, U. S. Geological Survey^{a/}Discharge at time of sampling

TABLE 6

CHENA RIVER AT FAIRBANKS

Suspended Sediment, Water Year October 1965-September 1966*
 (Where no concentrations are reported, loads are estimated)

Date	Mean Discharge (cfs)	Suspended Sediment	
		Mean Concentration (ppm)	Tons Per Day
<u>1965</u>			
October 14	1,500	96	390
<u>1966</u>			
January 28	300	--	4
May 4	1,330	27	98
May 5	1,880	46	240
June 18	2,120	21	120
June 30	2,200	22	130
July 1	1,950	19	100
July 22	1,100	14	43
July 27	964	14	35
July 31	892	12	29
August 1	884	17	40
August 16	710	14	27
August 29	788	14	30

*Data taken from Water Quality Records, 1966, U. S. Geological Survey

TABLE 7
CHENA RIVER AT FAIRBANKS
Bacteriological Examination for Coliforms,
Using Multiple Dilution Tube Method--1953*

Date Collected	Coliform Count, MPN/100 ml.	Discharge (cfs)
<u>1953</u>		
May 14	92,000	1,240
June 2	35,000	1,530
June 17	17,000	1,490
June 19	11,000	1,390
June 23	92,000	1,260
July 29	54,000	1,380
August 11	13,000	1,070
September 1	24,000	3,890
October 6	24,000	1,610

*Unpublished data, U. S. Public Health Service

TABLE 8
CHENA RIVER AT FAIRBANKS
Bacteriological Examination for Coliforms
Using the Membrane Filter--1966

Date Collected	Count/100 ml.	Discharge (cfs)
<u>1966</u>		
May 3	26,000	868
May 10	2,000	12,400
May 17	1,900	6,110
May 24	1,600	5,430
May 31	1,600	4,670
June 7	900	3,970
June 14	15,000	2,790
June 21	3,100	5,010
June 28	44,000	2,410
July 5	39,000	1,490
July 12	29,000	1,460
July 19	27,000	1,170
July 26	33,000	1,010
August 2	20,000	876
August 9	140,000	788
August 16	340,000	710
September 6	100,000	680
September 13	510,000	658
September 20	260,000	628
September 27	250,000	620
October 3	80,000	---

considerably higher than they were in 1953. Data collected since the 1966 period indicate a further increase in number.

Bottom Fauna

Bottom fauna of a river, because of its relative stability, is an excellent tool for measuring changes in the over-all condition of a river. In this report, it not only shows changes between the two periods of sampling, but also points out the effect of the present polluted condition. Table 9 is a comparison of organisms found within the polluted zone. These organisms were collected in an area of the river that is below all major sources of pollution. The 1953-54 collection, which is a composite of biweekly samples throughout the open water season, consists almost entirely of chironomids (Diptera) and annelids (Pleisiopora). One tipulid (crane fly) larva and one empid (dance fly) larva were collected. Table 10 shows the percentage by number of animals present. The 1966-67 collection is a composite of three sampling periods taken during the summer and fall of 1966 and the spring of 1967. These data display the diversity which is usually found in a relatively clean, unpolluted river. However, Table 10 shows that the greatest percentage of organisms present were the chironomids, followed by the annelids, with all other forms making up only a minor part of the collection. In an attempt to determine whether that was actually an indication of pollution, a further comparison was made between samples that were

taken at the same time, but from an area above all sources of pollution. These data are found in Tables 11 and 12. The data in these tables imply that the influence of the human population living along the lower river is having an effect. Not only are considerably more cleanwater species present in the upper river, but these species dominate the population percentage-wise, whereas the chironomids and annelids dominate the lower river.

There are no data available for the upper river during the earlier sampling period; however, the following is an excerpt from an unpublished study by the Alaska Water Control Board in 1955:

"Stream pollution is apparent in the Chena River both microscopically and macroscopically in examinations of biological samples of the Chena River below the Little Chena tributary.... In the upper portions of the Chena, a complete biological cycle is illustrated. There appears to be a bacterial and protozoan population with the appropriate plant life followed by crustaceans, insects, fish, birds and mammals typical of an unpolluted stream."

Unfortunately, no data are available for the 1952-53 period on the plankton and "aufwuchs" organisms.

Fish

Although no quantitative data are available for fish populations in the river for the two periods, in 1953 the U. S. Fish and Wildlife Service produced a preliminary report on the Fish and

TABLE 9
CHENA RIVER AT FAIRBANKS
A Comparison of Taxonomic Groups
Within the Polluted Zone, 1953-54 and 1966-67

Organism	1953-54*	1966-67
Annelida		
Plesiopora	X	X
Hydracarina		
Libertia sp.		X
Plecoptera		
Isoperla sp.		X
Ephemeroptera		
Ephemerella sp.		X
Centroptilium sp.		X
Trichoptera		
Pycnopsyche sp.		X
Hesperophylax sp.		X
Tipulidae	X	X
Simuliidae		X
Chironomidae		
Metriocnemus sp.		X
Hydrobaenus (Smittia) sp.	X	X
Hydrobaenus (Trichocladius).	X	X
Hydrobaeninae	X	X
Diamesinae	X	
Prodiamesa sp.		X
Tanytarsus (Calopsectra) sp.	X	X
Brillia sp.		X
Psectrocladius sp.		X
Tendipedini	X	
Polypedilum sp.	X	
Cryptochironomus sp.	X	
Rhagionidae		
Atherix sp.		X
Empididae		
Hemerodromia sp.	X	

*Unpublished data, U. S. Public Health Service

TABLE 10
CHENA RIVER AT FAIRBANKS
A Comparison of Taxonomic Groups
Within the Polluted Zone by Percentage

Order	1953-54*	1966-67
Plesiopora	36.0%	0.4%
Plecoptera	--	0.1
Ephemeroptera	--	0.2
Trichoptera	--	0.1
Diptera	64.0	99.2

*Unpublished data, U. S. Public Health Service

TABLE 11

CHENA RIVER NEAR FAIRBANKS

A Comparison of Taxonomic Groups
Within the Polluted and Unpolluted Zones, 1966-67

Organism	Polluted	Unpolluted
Annelida		
Plesiopora	X	
Hydracarina		
Libertia sp.		X
Plecoptera		
Isoperla sp.	X	X
Isogenus sp.		X
Alloperla sp.		X
Brachyptera sp.		X
Ephemeroptera		
Ephemerella sp.	X	X
Centroptilium sp.	X	
Heptagenia sp.		X
Pseudocloen sp.		X
Paracloedes sp.		X
Metratropus sp.		X
Epeorus (Iron) sp.		X
Baetis sp.		X
Ameletus sp.		X
Hemiptera		
Corixidae		X
Trichoptera		
Pycnopsyche		X
Hesperophylas	X	
Tipulidae		
Tipula sp.	X	X
Dicranota sp.		X
Simuliidae		
Simulium vittatum	X	
Cnephia emergens		X
Chironomidae		
Metriocnemus sp.	X	X
Tanytarsus sp.	X	X
Cardiocladius sp.		X
Spaniotoma sp.		X
Smittia sp.	X	X
Brillia sp.	X	
Psectrocladius sp.	X	
Prodia mesa sp.		X
Pentaneurini		X
Rhagionidae		
Atherix sp.	X	

TABLE 12
CHENA RIVER AT FAIRBANKS
A Comparison of Taxonomic Groups
From Polluted and Unpolluted Zones by Percentage

Order	Polluted	Unpolluted
Plesiopora	0.4%	---%
Plecoptera	0.1	35.7
Ephemeroptera	0.2	41.2
Trichoptera	0.1	12.5
Diptera	99.2	10.6

Wildlife Resources of the Chena River in relation to the Corps of Engineers' tentative flood control plan. The following is an excerpt from that study:

"....Through the years of 1904-1909, large numbers of king salmon were taken by gillnets in the Fairbanks area during the first two weeks of July. Silvers and chum salmon were harvested during early fall. Whitefish, northern pike, grayling and ling cod comprised the freshwater fish population of the watershed. Since 1909 there has been a marked decline in both anadromous and freshwater fisheries. Grayling is the only species that has managed to withstand the onslaught of civilization.... The anadromous fishes, whitefish, ling cod and northern pike, once abundant, are seldom if ever currently taken from these waters. No sport fishing for grayling is done in the Chena River from the confluence of the Little Chena to the mouth because of the pollution. The angler must travel upstream by boat a distance of approximately 40 miles from Fairbanks to reach desirable grayling water...."

The condition described above has changed considerably. Although there are no salmon fisheries, there is a small king and chum salmon run in the river. There are also grayling, northern pike, whitefish, ling cod and suckers, plus a small run of sheefish in the lower reaches. The Alaska Fish and Game Department is presently engaged in a population estimation and creel sampling program in this portion of the river. To point out the change in conditions

described for the 1953 period when fishermen needed to travel upstream for grayling fishing. Fish and Game personnel report that approximately 20,000 man hours were spent fishing on the Chena on the lower 30 miles during 1968. By far the largest portion of this was for grayling.

VI. DISCUSSION

At the present time the Chena River is considered an excellent grayling fishing stream, sustaining side fishing for northern pike, burbot and sheefish. This was not always so! Obviously, changes have taken place which have improved the fish's environment. What are these changes and what caused them to take place?

In the past few pages some of the practices which may have caused such changes and the changes themselves have been discussed. But by what manner or by the effect of which entity or entities did the present ecological condition evolve? As is usually the case in biological evolution, it was probably a sequence of events brought about by many factors, some of which are more forceful than others. After a careful evaluation of the chemical data available, there obviously have been only two chemical changes in the quality of the water which could have an effect on the over-all ecology of the stream. The shift in the pH values from basic to neutral during the open water periods might possibly have such an effect. During the early analysis of the data, it was the author's opinion that such a small difference in the pH values could have little effect on the aquatic population, since there were no organisms present which relied on a basic pH, i.e., snails, clams, etc. However, unpublished data have recently been produced at the Alaska Water Laboratory indicating that very small changes in pH can bring

about large changes in total bacterial counts. It is feasible that this could trigger a sequence of events which would change the entire ecological picture; however, it is more logical that other forces have had a greater effect on the organisms and, in themselves, may have caused the shift in pH.

As stated earlier, dissolved oxygen is the other change in water quality which might have had a considerable effect on the flora and fauna of the river. The dissolved oxygen regime of arctic and subarctic rivers differs considerably from temperate streams. As can be seen in Figure 5, the dissolved oxygen content remains high during the warm, ice-free months, but begins to diminish with the advent of ice cover. Along with the ice cover, which restricts or eliminates surface reaeration, comes a heavy snow cover. As the winter moves along, the amount of light available for photosynthesis constantly diminishes. All of these factors combine to decrease the amount of oxygen available for aquatic respiration which is apparently quite demanding because of the adaptation of indigenous organisms to extremely low temperatures. As a result, the oxygen supply begins to diminish and it is not unusual for an arctic or subarctic river under natural conditions to lose 75% of its oxygen; some lose more than 90%. Apparently the organisms indigenous to the Chena River were able to tolerate the levels of oxygen which prevailed during the 1967-68 period. Additional information not included in this report also indicates that desirable populations

were capable of withstanding oxygen levels lower than those that prevailed during the 1951-52 period. Therefore, it is probable that dissolved oxygen played a very small part, if any, in the change in the biota.

On the other hand, this could have a very important bearing on the assimilative capacity of a stream. If the dissolved oxygen in rivers under natural conditions is reduced to 2 or 3 ppm, what will happen to the remaining oxygen if a heavy BOD load is added to the river by a municipality? Two factors are involved which may make such a loading possible. From all indications, the organisms present within such streams have become acclimated to much lower dissolved oxygen levels than one might usually expect. If so, then we must take a closer look at the lower limits we have placed on dissolved oxygen. Even though the respiration rates at low temperatures are somewhat reduced, with a resultant reduced rate in oxygen utilization, the oxygen level is so low that any appreciable BOD loading would probably reduce the remaining dissolved oxygen to unacceptable levels. Furthermore, a river carrying a very low supply of dissolved oxygen would probably not be capable of assimilating a moderate COD load since it demands oxygen much more rapidly than biological respiration.

At the present time the Alaska Water Laboratory has studies under way to determine the major causative factors of oxygen reduction under ice and to what extent the problem exists throughout the state.

If, as suggested, none of the chemical parameters changed sufficiently to bring about the change in the aquatic populations, what did bring about the change? It is well documented that a heavy sedimentation load can have detrimental effects on all links of a food chain. In addition, a sediment load can also affect the pH and dissolved oxygen in a river. The data in this report suggest that there was sufficient sediment during the earlier study to have ill effects on the aquatic population of a river. The data further suggest that there was a constant shifting and scouring of the bottom. These factors in combination probably reduced the food organisms in the river with the resulting reduction in fish. During the time between the two sampling periods, the sediment load became greatly reduced due to the reduced gold mining activity and the restriction of the Tanana River to its own basin; as a result the Chena River bottom returned to its original condition of cleanly washed sand and rubble. With the return of this condition, food organisms have again established themselves and fish populations are returning to normal. It would seem, then, that the reduction and elimination of the aquatic population and its return are direct results of the heavy sediment load and its ultimate removal from the river.

Even though the water quality of the river has improved to where it is now acceptable to fish and other desirable aquatic organisms, from a public health standpoint it is grossly polluted. The data in Tables 7 and 8 show that coliform counts in 1953 were

very high and have risen considerably since then. In 1953 the highest count was 92,000/100 ml with a river discharge of 1260 cfs. In 1966 the highest count was 510,000/100 ml with a discharge of 685 cfs. As long as coliforms appear in the river in these numbers, the water will not meet the standards set by the Alaska Department of Health and Welfare in 1967 for drinking water supply, bathing, swimming, growth and propagation of fish, agricultural water supply, and industrial waste supply where worker contact is required. So it is apparent that much needs to be done to improve the quality of the Chena River. However, there is one point of extreme importance: even though there has been an increase of 57% in the human population, with a resultant increase in waste entering the river, the river is now both esthetically and ecologically more acceptable than it was 15 years ago.

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